EVALUATING THE PROSPECTS OF CLOSED-CIRCUIT TELEVISION (CCTV) CAMERAS USAGE IN THE EXECUTION OF CONSTRUCTION PROJECTS IN LAGOS STATE, NIGERIA

[1]Ijigah, E. A. and [2]Ogunlusi, I. O.

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[1]Department of Building, Federal University of Technology, Akure, Ondo State, Nigeria

Correspondence
eaijigah@futa.edu.ng; ifedayoogunlusi2022@gmail.com

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ABSTRACT

In the past, construction practitioners used to employ physical supervision of projects in the field. Nevertheless, the changes in digital technologies in the recent past, including the Information and Communication Technologies (ICT) and design software and Building Information Modelling (BIM), have intensified the use of Artificial Intelligence (AI) in construction processes. Such technological advances have brought new practices where the use of Closed-Circuit Television (CCTV) cameras have become an effective means of monitoring a site and project management. This research examined the role of CCTV in implementing building construction projects in Lagos State, Nigeria with an intention of improving the performance of the projects. It also evaluated the impacts of use of CCTV on the execution of the building projects within the study area. Primary and secondary data were utilized. Primary data were collected by the use of questionnaires, whereas secondary data were collected in journals, conference papers and research archives. A convenient random sampling technique was used to administer 300 questionnaires to the selected construction professionals such as architects, builders, and engineers. Among them, 168 (56) questionnaires have been returned and analyzed. The results revealed that application of CCTV cameras in the construction project implementation will result into enhanced site security, real time monitoring of the project and enhanced project management. The research thus suggests that more use of the CCTV technology should be embraced in the study area to improve the overall performance of the building construction projects.

Keywords: Closed-Circuit Television (CCTV) camera; Construction; and supervision

1. | Introduction

Construction projects entail a variety of role players, among them; professionals like architects, engineers, builders, and contractors and non-professional who include, skilled and unskilled workers. In the majority of the projects, the professionals are expected to monitor closely the work of the non-professional operatives to enhance the performance of the project. According to Oyewobi *et al.,* (2017), some of the major functions performed by professionals include the supervision, monitoring, evaluation, and general management of projects in construction works to make sure that cost, time, and quality objectives are achieved. In the past, it has been proven that proper monitoring, supervision, tracking, evaluation, and project management can play a huge role in enhancing the quality of the project (Amin *et al.,* 2017; Musyimi and Ondara, 2022). In addition, it is evidenced that professionals in the construction business should

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be involved in the early and active phases of the construction business because this reduces the reworking and speeds up the project completion (Walker *et al.,* 2022; Karimulla *et al.,* 2024).

Manual visits to the site and periodic checks as the traditional practice of supervision do not always serve the purpose of receiving real-time data on the state of affairs at the site and the emergence of risks (Amin *et al.,* 2017). Conversely, Closed-Circuit Television (CCTV) cameras provide a more active and comprehensive monitoring structure that will allow the concerned parties to observe the activity of the sites remotely and regulate the working processes more efficiently and timely (Paulius *et al.,* 2022).

Some of the industries that have embraced the use of CCTV cameras include security (Welsh *et al.,* 2020), law enforcement (Slobogin and Brayne, 2023), and traffic control (Abdel-Aty *et al.,* 2022) to improve surveillance and control. CCTV cameras, in the construction industry, hold much potential in terms of facilitating supervision, minimizing errors, enhancing safety, and deterring crime (Aliu and Oke, 2023). They also participate in the acquisition of better project schedules, cost reduction, and site security (Dave *et al.,* 2023) according to the recent studies.

There are a number of advantages of using CCTV cameras in the supervising of the construction site. They have a real time tracking facility that enables project managers and site supervisors to identify the problems and resolve them in good time hence reducing delays, getting most of the resources utilized and improving the overall project efficiency.

1.1 | CCTV Definitions

Closed-Circuit Television (CCTV) is a system of video cameras and monitors that are mostly used to oversee. It has the primary role of capturing and recording activities within the premises of private properties. CCTV is important in crime prevention, surveillance, identifying and arresting criminals, prosecuting criminals in court, and protecting company resources (Dave *et al.,* 2023). CCTV cameras are important to improve the level of security, deter crime, and control actions in several settings including homes, businesses, the open space, and transportation (Welsh, 2020).

Closed-Circuit Television camera or CCTV camera is an inseparable component of a CCTV system. It records the video and transmits it to a monitor or a video recorder in a closed circuit.

1.2 | The Need for Supervision on Construction Sites

As Oyewobi *et al.,* (2017) underlined, supervision is an important element of the construction projects due to several reasons. They are the adherence to the required standards, the verification that the construction is proceeding within the a:roved time schedule, the instillation of integrity and hard work in the site operatives, and the evaluation of the construction works by the final project report. Supervision is also useful in ensuring that the contractors deliver in accordance with the requirements stipulated by law regarding the performance of construction works, and to report promptly any defects, irregularities, or shortcomings observed to the a:ropriate authorities and recommendations made on how to rectify them.

The construction industry is an industry that requires a lot of human input and output since it is a labor intensive industry. In spite of the technological progress, the labor productivity remains one of the key threats facing the industry (Soham & Rajiv, 2013; Ming-Sum, 2005).

1.3 | Impacts of Supervision on Workers' Productivity

The performance and efficiency of the labor force are very strong factors that affect construction productivity (Jergeas, 2009). As one of the main aspects of construction activities, to enhance productivity, one needs not only sufficient supply of resources and effective labor control, but

also enhanced supervision, innovations, and implementation of contemporary technologies (Jergeas, 2009). Research has indicated that productivity of labor in construction business is boosted when there is proper supervision. Frimpong *et al.,* (2011) also observed that effective supervision has facilitated motivation of workers, better time management, fewer grievances, and more positive feedback as well as facilitating the use of best practices that will result in high performance.

Oyewobi (2017) noted that construction supervisors are able to enhance productivity by knowing how to influence workers to develop positive attitudes, continuous working process and maximize output. They are strong leadership and good management in the construction works which aid to a high productivity since they minimize production costs, cut the execution time, boost profitability, quality and efficient utilization of resources. The technological improvements that support these benefits include Artificial Intelligence (AI), Building Information Modelling (BIM), CCTV surveillance systems, 3D scanning, drone technology, and virtual reality (VR) (Aliu and Oke, 2023; Chen *et al.,* 2023).

Also, the knowledge of the workers and site operatives that their operations are being surveyed by surveillance cameras is useful in minimizing time wastage, delays in tasks, and eventually increasing productivity.

1.4 | Checkmating the Activities of Waste Scavengers and Cart Pushers

Scavengers contribute to waste recycling by informally retrieving and sorting valuable materials like paper, aluminum, glass, and metals, which are then sold to recycling industries. For many unemployed youths, scavenging serves as a vital source of income, helping them sustain themselves and support their families (Mustapha, 2010). However, waste scavenging which ought to be a tool for poverty reduction among the unemployed youths have been an avenue for some unscrupulous ones among them who just want to make money by hook or by crook. Therefore, they break into construction sites to vandalize and cart away infrastructures and valuable materials to sell off at ridiculous prices.

Beyond environmental and health risks, scavengers are increasingly linked to criminal activities such as theft, vandalism, stri:ing metal fittings from unguarded construction sites leading to cost overrun, delay due to re-work and replacement; and eventually collapse from removing critical metal parts. With the usage of closed-circuit television (CCTV) cameras on building construction projects sites during execution for surveillance, the menace of indiscriminate scavenging could be checked and curbed.

1.5 | Theft and Vandalism Issues in Construction Industry

The theft and vandalism are still a serious issue to construction sites and their incidences usually depend on the nature of the project- whether it is housing development and road works or a dam, an airport and stadium construction. This paper will analyze the essence of construction site theft and vandalism, security measures and technologies that are used to control the prevalence of these.

The activities of thieves and vandals have a direct negative effect on the success of the project and make it much more unprofitable. According to Farinloye *et al.,* (2009), the crimes are one of the biggest issues of the construction industry and remain a threat. A study by Berg and Hinze (2005) also revealed that in most cases, theft causes more financial losses to big companies and vandalism causes more cost effects to small companies- although the big companies tend to spend more on anti-crime programs. Such criminal acts against the global construction industry cost millions of dollars every year, and the evidence indicates costs increase annually (Berg and Hinze, 2005).

The cases of theft and vandalism have also increased in the recent years and have become wicked problems in the industry. The construction sites are the ones that are most a:ealing since they have valuable materials that can be stored over a long period of time, sites are accessible all night or on weekends and the security systems which are available are either ineffective, easily defeated or costly to most contractors. The risks are especially hard to control on large projects because casual labor complicates the tracking of the workforce, and the large number of materials and equipment is hard to track. Some of the factors that contribute to this include the absence of new security technologies, low level of motivation and welfare among the staff, economic downturn and high unemployment rates.

Moreover, numerous contractors do not report any stolen items when such misa:ropriation is less than deductibles in insurance, and petty vandalism is usually perceived as a standard business expense. However, all these losses are massive, with average contractors spending millions of naira every year on theft, vandalism, and insecurity (Ephraim, 2020). Farinloye *et al.,* (2009) noted that theft and vandalism are rampant in the construction sites in Lagos, Nigeria, and it has been a major threat to project delivery and profitability.

CCTV cameras can be used in the construction sites of buildings to have an o:ortunity to improve the performance and outcomes of the projects.

1.6 | The Prospects of CCTV Cameras On Productivity And Efficiency of Construction Projects

i. **Improved Security Measures:** The presence of CCTV cameras prevents theft and vandalism and leads to the arrest and prosecution of criminals who defy within the construction site. CCTV cameras can be used to achieve timely project completion within budget by ensuring that there are no risks of theft and vandalism. The possible perpetrators will have low chances of committing crimes when they are aware that they are under surveillance.

ii. **Monitoring Construction Progress:** Monitoring of the construction work can also be conducted using CCTV cameras which enable the project managers to have an eye on the work being done and there could also be areas that need attention. This may assist in increasing the productivity and ensure that high quality and standard work is done in the project. It aids coordination.

iii. **Reduction in Accidents and Injuries:** CCTV cameras can be used to minimize accidents and injuries occurring in construction sites. Surveillance of the site enables project managers to notice the possible dangers and measure to mitigate them before they can lead to the injury of workers. Cameras assist in real time checking of safety adherence, minimizing accidents. CCTV cameras footage can be viewed in case of accident occurrence in order to examine accidents and enhance future safety measures.

iv. **Legal Considerations:** It should be mentioned that the use of CCTV cameras should be made according to the existing laws and regulations. The project managers are required to take care that their deployment of CCTV cameras does not violate any existing privacy laws and regulations and that the workers are supervised that they are under monitoring. Video tapes may act as evidence in the event of a court of law dispute or claims.

v. **Progress Tracking:** Cameras provide a visual record of project progress, aiding in scheduling management meetings and reporting.

vi. **Effective and Better Communication**: Camera evidence helps in making better communication between stakeholders. The site conditions can also be accessed quickly, allowing quicker decision-making.

vii. **Remote Supervision:** Project managers are able to check the sites remotely so that they can oversee several sites without the need to visit them.

viii. **Quality Control:** This is done through constant monitoring so that the construction work is of quality. A camera video can be used as a document of quality assurance evaluation and control.

ix. **Effective Resource Management:** With regard to labor and resources, more effective utilization of labor and resources is achieved through efficient workforce management and enhanced monitoring.

x. **Savings in Costs:** Increased security and safety will result in reduction of insurance premium costs. By detecting mistakes early, errors are minimized through less rework and the costs associated with it are also minimized.

xi. **Reduced Downtime:** The fast detection of problems minimizes the downtime and the costs associated with it. Hence, it prevents delays.

xii. **Time study and work measurement:** Time study and work measurement could be well administered without intruding on the activities of the workers physically. Time study is a scientific procedure of directly observing and documenting human labor using a timing device (Akanni, 2024), in order to calculate how much time a qualified worker would require in performing an activity at a given performance standard. The viewer must be placed in a reasonable place where the workers can be fully seen in the works and movements and at the same time not to distract them.

xiii. **Short-term Response:** CCTV cameras enable to watch the actions on the site in real-time and provide the o:ortunity to respond to accidents or unsafe behavior promptly. This can save a lot of time on addressing safety hazards.

xiv. **Safety Compliance:** Supervisors can ensure that safety protocols, such as the use of personal protective equipment (:E), are followed. Cameras can identify workers who are not complying with safety regulations, allowing for immediate corrective action.

xv. **Hazard Identification:** Cameras can help in identifying potential hazards, such as uncovered trenches, unstable scaffolding, or faulty equipment, before they cause accidents. Cameras aid accident prevention.

2. | Research Methodology

The questionnaire survey was conducted on the professionals in the building construction sector of the Lagos State, Nigeria, who are Builders, Quantity Surveyors, Architects, Engineers (Mechanical, Structural, and Electrical) and Project Managers. The selection of the respondents was on the basis of their availability and interest to participate in the research. The questionnaire was well-constructed to determine the effects of application of CCTV cameras when undertaking the construction of buildings. Convenience sampling method was applied to issue 300 questionnaires to construction professionals out of which 168 returned which gives a response rate of 56 percent and this was analyzed. This was considered sufficient according to Kothari (2004) who indicated that survey results can be considered objective and unbiased when the rate of returns is not less than 40-50%. Sample size can be defined as the quantitative measure of the size

of the selected elements or participants of a bigger population. The questionnaires were sent via email and messaging services with the respondents urged to fill them within a given time. The findings were made in tabular form and data analysis was done using statistical methods like percentages, mean scores, standard deviation, factor analysis and other techniques like these.

3. | Discussion of the Findings

Table 1 shows the impact of using CCTV cameras whenever implementing the construction of buildings. These impacts were evaluated on the basis of the feedbacks of three important professional groups such as Architects (19.64%), Builders (28.75%), and Engineers (43.45%) who collectively comprised 91.66 percent of the total number of respondents and hence the foundation of the analysis.

Real-time monitoring was the highest among the Architects by having a Mean Score (MS) of 4.07 and Standard Deviation (SD) of 0.54. This was then succeeded by better security (MS = 4.00; SD = 0.66) and remote supervision (MS = 3.82; SD = 0.50). This group rated the reduction of costs of construction (MS = 2.92; SD = 1.09) as the least important effect.

Improved project management (MS = 3.86; SD = 0.71), improved record keeping (MS = 3.86; SD = 0.55) and reduced disputes (MS = 3.85; SD = 0.80) by constructors were ranked as the first, second, and third best respectively. Just like the Architects, Builders also evaluated the lower costs of construction as the least impact of the use of CCTV (MS = 2.83; SD = 1.07).

The greatest benefit according to the engineers was curbing the activities of scavengers (MS = 3.99; SD = 0.69), work measurement (MS = 3.85; SD = 0.89) and improved project management (MS = 3.82; SD = 0.84). Lower construction cost was again ranked as the last one (MS = 2.80; SD = 0.78).

In general, the respondents perceived three major impacts of the usage of CCTV cameras as the enhancement of security (MS = 3.86; SD = 0.70), real-time construction activities monitoring (MS = 3.85; SD = 0.59), and project management enhancement (MS = 3.83; SD = 0.80). On the contrary, the lowered building price became the least important variable (MS = 2.84; SD = 0.97).

A Kruskal-Wallis test was used to test the hypothesis that there was an agreement or a variation of opinions among professional groups. The findings showed an overlap in the perception of the respondents regarding ten of the sixteen effects identified. Nevertheless, the divergence in the opinion was high on six aspects: real-time monitoring ($p = 0.001$), curbing the threat of scavengers ($p = 0.000$), remote supervision ($p = 0.029$), better record keeping ($p = 0.000$), improved project performance ($p = 0.005$), and work measurement ($p = 0.000$*). These results show that there is statistically significant difference ($p < 0.05$) in the perceptions of these specific effects by Architects, Builders and Engineers.

Although these differences exist, all sixteen of the effects were not low in mean scores with the lowest mean score of 2.84 and the general mean score being 3.64. This indicates that the effects of CCTV camera use in the building construction projects in the study area are usually substantial.

3.1 | ANOVA of Effects of Using CCTV Cameras on the Execution of Construction Projects.

The Analysis of Variance (ANOVA) shows the impact of the utilization of CCTV cameras in carrying out building construction projects in Table 2. It is observed in the table that the calculated F-statistic (3.72) is more than the critical F-value (3.35) using three groups (K = 3) and a total sample size of N [?]. 30. This result shows that the perceptions of the professionals, who are Architects, Builders, and Engineers, on the impact of the use of CCTV cameras in executing construction projects differ

Table 1 | Effects of Using CCTV Cameras on the Execution of Construction Projects

Effects of Using CCTV Cameras on the Execution of Construction Projects	Architect			Builder			Engineers			Overall			Asymp. Sig
	Mean	S.D.	Rank	Mean	S.D.	Rank	Mean	S.D.	Rank	Mean	S.D.	Rank	
Improved security	4.00	0.66	2	3.84	0.72	6	3.80	0.69	5	3.86	0.70	1	0.315
Real-time monitoring	4.07	0.54	1	3.84	0.52	4	3.73	0.66	7	3.85	0.59	2	**0.001****
Enhance projects management	3,80	0.61	4	3.86	0.71	1	3.82	0.84	3	3.83	0.80	3	0.945
Curbing the menace of scavengers	3.46	0.77	12	3.77	0.78	8	3.99	0.69	1	3.79	0.77	4	**0.000****
Enhanced site surveys	3.80	0.85	6	3.75	0.79	9	3.80	0.78	6	3.78	0.79	5	0.650
Remote supervision	3.82	0.50	3	3.84	0.67	5	3.59	0.71	13	3.74	0.67	6	**0.029***
Enhanced quality control	3.57	0.81	8	3.74	0.87	10	3.80	0.68	4	3.73	0.79	7	0.229
Reduced disputes	3.49	0.83	11	3.85	0.80	3	3.65	0.83	8	3.70	0.83	8	0.130
Remote sensing	3.80	0.40	5	3.71	0.60	11	3.61	0.94	12	3.69	0.72	9	0.340
Better record-keeping	3.20	0.44	14	3.86	0.55	2	3.65	0.64	9	3.64	0.62	10	**0.000****
Improves project performance	3.53	0.91	9	3.82	0.96	7	3.49	0.55	15	3.63	0.83	11	**0.005****
Compliance monitoring	3.41	0.86	13	3.70	0.85	12	3.61	1.05	11	3.61	0.94	12	0.072
Increased productivity	3.51	0.50	10	3.50	0.65	14	3.62	0.64	10	3.55	0.62	13	0.245
Improved safety	3.59	0.74	7	3.53	0.70	13	3.53	0.90	14	3.54	0.79	14	0.825
Work measurements	3.18	0.65	15	3.39	0.69	15	3.85	0.89	2	3.52	0.81	15	**0.000****
Reduced costs	2.92	1.09	16	2.83	1.07	16	2.80	0.78	16	2.84	0.97	16	0.435

Test Statistics: a) Mean Item Score,
b) Kruskal Wallis Test (Grouping Variance – professionals (Architects, Builders and Engineers) on effects of using CCTV Cameras in the execution of building construction projects).
** Significant at the 0.01 level, *Significant at the 0.05 level.
Source | Field survey

Table 2 | ANOVA of Effects of Using CCTV Cameras on the Execution of Construction Projects

Professionals	N	Mean	Std. deviation	Std. error	F	Sig
Architects	33	3.57	0.70	0.49		
Builders	44	3.68	0.74	0.67	3.72	0.03
Engineers	73	3.65	0.77	0.75		

Source | Field survey

statistically. As a result, post-hoc analyses were carried out to determine the professional groups that had varying views.

3.2 | LSD Post hoc test of effects of using CCTV cameras in the execution of building construction Projects.

The findings of the post hoc analysis done to determine where the differences observed exist among the respondents based on their professional roles; Architects, Builders, and Engineers, on construction projects are shown in Table 3. The Least Significant Difference (LSD) post hoc test shows that there is a statistically significant difference in perceptions that exists between Architects and Engineers in terms of the impact of the application of CCTV cameras during the implementation of building construction projects with a p-value of 0.02.

Table 3 | LSD Post hoc test of Effects of Using CCTV Cameras on the Execution of Construction Projects.

Stakeholders	Test statistic	Std. error	Std. test statistic	Sig.	Adj. Sig.
Architects - Builders	14.22	9.19	1.64	0.10	0.600
Architects – Engineers	30.45	11.19	3.62	0.00	**0.002**
Builders – Engineers	35.45	11.07	2.29	0.02	0.075

4. | Conclusion

The outcome of the ANOVA test revealed that statistically significant difference exists between the perception of Architects, Builders, and Engineers on the impacts of using CCTV cameras in carrying out building construction projects. The results of the LSD posthoc test further revealed that there is significant difference between Architects and Engineers ($p = 0.02$) in the six items previously discovered using the Kruskal-Wallis test.

The main impacts of the installation of CCTV cameras in construction projects in buildings are that, there is security of the site, construction activities are monitored in real-time, project management is enhanced, construction activities are minimized, project performance is improved and scavengers are monitored remotely.

In sum, the evaluation of the CCTV camera application in building construction projects indicated that CCTV camera application has the capability of enhancing the performance of the construction projects to a high degree in Lagos State, Nigeria.

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